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**FORAMINIFERA FROM VENEZUELA
AND TRINIDAD**

By

HELEN K. HODSON

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INTRODUCTION

The collections upon which this article is based were made in Venezuela for an American company and in Trinidad by Prof. Harris. Only descriptions of species with general localities and general ages can be given at present, but later when the interests of the company permit, we hope to publish definite localities and stratigraphic ranges for the species. Fine distinctions between species and subspecies have been made for stratigraphic purposes; further work may make still closer distinctions advisable.

Among the many people to whom acknowledgments are due for help in this article are especially:

Prof. G. D. Harris for material from Trinidad and for the use of his laboratory at Cornell University.

Prof. F. L. Whitney of the University of Texas for an abundance of specimens of various species of *Orbitolina* from Texas and France for comparison.

Dr. Floyd Hodson for reading the manuscript and photographing the specimens as well as assisting frequently in the work.

DESCRIPTION OF SPECIES

Order FORAMINIFERA d'Orbigny

Family LITUOLIDAE Brady

Subfamily ORBITOLININAE Prever

Genus ORBITOLINA d'Orbigny

- Orbitolina texana*** (Roemer) Pl. 1, figs. 2, 4.
Orbitulites texanus Roemer, 1849, Texas, p. 392.
Orbitulites texanus Roemer, 1852, Die Kreidebildungen von Texas, p. 86, pl. 10, figs. 7a, b, c, d.
Orbitolina texana (Roemer), P. L. Prever, 1905, Boll. Soc. Geol. Italiana, vol. 23, fasc. 3, p. 468.
Orbitolina texana (Roemer), J. A. Cushman, 1921, Thirteenth Annual Report, Fla. State Geol. Survey, p. 42.
Orbitolina texana (Roemer), D. O. Carsey, 1926, University of Texas Bull., No. 2612, p. 22, pl. 6, figs. 6a, 6b, 6c.

A comparison with specimens of *O. texana* (Roemer), *O. walnutensis* Carsey and *O. whitneyi* Carsey from Texas and *O. lenticulata* (Lamarck) from France was made possible by Prof. F. L. Whitney who kindly sent abundant material. The only difference between the specimens of *O. texana* from Texas and Venezuela is that those from the latter place are usually slightly smaller, although many are identical. *O. lenticulata* (Lamarck) is still smaller and thicker. *O. venezuelana* (Karsten)¹ as figured is a much smaller species even than *O. lenticulata* (Lamarck).

Although this is the most abundant form in the present collection, there occur with it flat and convex variations whose limits are marked by the two new subspecies *O. texana asaguana* and *O. texana monagasana*, respectively. These subspecies were found among the specimens of *O. texana* (Roemer) sent from Texas, also.

Age: Cretaceous (Aptian, *vide* Collet²).

Locality: Río Asagua, State of Monagas, Venezuela,

¹ Herman Karsten, 1866, Géologie de l'Ancienne Bolivarienne, etc., p. 62, pl. 6, fig. 6.

² L. W. Collet, Archives des Sci. Phy. et Nat., vol. 4, 1922, pp. 16-17.

locality number 2216.

Orbitolina texana asaguana, n. subsp.

Pl. 1, figs. 6, 8.

This subspecies marks the limit of variation in *O. texana* (Roemer) toward being very convex. There are all gradations between the two forms and their convexity is the only difference.

Age: Cretaceous (Aptian, *vide* Collet, *l. c.*)

Locality: Río Asagua, State of Monagas, Venezuela, locality number 2216.

Orbitolina texana monagasana, n. subsp.

Pl. 1, figs. 7, 9.

This subspecies marks the limit of variation in *O. texana* (Roemer) toward being flat. The two surfaces are only slightly concave and convex, respectively, instead of being moderately so. Otherwise, the two forms are similar and there are all gradations between the two.

Age: Cretaceous (Aptian, *vide* Collet, *l. c.*)

Locality: Río Asagua, State of Monagas, Venezuela, locality number 2216.

Orbitolina thompsoni, n. sp.

Pl. 1, figs. 1, 5.

The test is fairly large, about 7–8 mm. in diameter, raised at the center and curled up on the edge like a wide hat. The other side is concave.

This species is easily distinguished from *O. texana* (Roemer) and its two new subspecies by the hump in the middle and the irregularly curled up edges. It does not attain the large size of *O. whitneyi* Carsey¹, is more raised at the center and not fluted on the edges. It is many times larger than *O. venezuelana* (Karsten), *l. c.* The form it most closely resembles was found among specimens of *O. texana* (Roemer) from Texas kindly sent by Prof. F. L. Whitney. However, these few from Texas are thicker and raised higher at the center.

Named in honor of Mr. V. A. Thompson, who collected the material.

¹ D. O. Carsey, 1926, University of Texas Bull., No. 2612, pp. 22–23, pl. 6, figs. 9a, 9b.

Age: Cretaceous (Aptian, *vide* Collet, *l. c.*)

Locality: Río Asagua, State of Monagas, Venezuela, locality number 2216.

Family NUMMULITIDÆ (H. Douvillé ?)

Subfamily NUMMULITINÆ Brady

Genus HELICOLEPIDINA Tobler

***Helicolepidina spiralis* Tobler**

Lepidocyclina (Helicolepidina) spiralis Tobler, 1922, *Eclogæ Geol. Helvetiæ*, vol. 17, no. 3, pp. 380-384, figs. 1-3.

Helicolepidina spiralis Tobler, H. Douvillé, 1923, *Eclogæ Geol. Helvetiæ*, vol. 17, no. 5, pp. 566-569, figs. 1, 2.

Helicopelidina spiralis Tobler, H. Douvillé, 1924, *Bull. Soc. Géol. France*, vol. 23, pp. 375-376, figs. 3, 4.

Helicolepidina spiralis Tobler, G. D. Harris, 1926, *Johns Hopkins University Studies in Geol.*, no. 7, p. 104, pl. 18, figs. 4, 5.

H. spiralis Tobler is a fairly common species usually occurring with forms intergrading between it and its new subspecies *tenuis*. The different shapes which this species assumes resemble the phases of *Lepidocyclina hubbardi* (n. sp.). *H. spiralis* Tobler corresponds to the fat form, *L. hubbardi bolivarensis* (n. subsp.); *L. hubbardi* (n. sp.) with the swelling at the center, and its flat subspecies *aurarensis*, are similar to rare variations of *H. spiralis* Tobler which in the present collections are too scarce to be worthy of names; the common *H. spiralis tenuis* (n. subsp.) corresponds to an intermediate stage between *L. hubbardi* and its new subspecies *aurarensis*.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality number 3256 (one specimen ?), 3268 (and variation), 3304, 3312 (variation), 3317; Point Bontour, Trinidad.

***Helicolepidina spiralis tenuis*, n. subsp.**

Pl. 1, figs. 11, 12.

The test is small and although it attains 4 mm., most of the specimens measure only slightly more than 2 mm. in

diameter. It is thin, slightly raised at the center, where it does not surpass a millimeter in thickness, and slopes gradually to the wide fragile border. The surface is covered with an irregular mesh, with rudimentary papillæ at the center in a few specimens. The equatorial layer shows an embryo of 2 adjacent cells, one of which is larger than the other; frequently in grinding, the embryo looks unicellular as the smaller cell is about the size and shape of the central equatorial cells; the larger one is practically round and measures as an average $152\mu^1$ in diameter; the smaller one measures only slightly less in its greatest dimension and is hemispheric in shape. The equatorial cells are of various sizes; those forming the spiral are large; those at the periphery are large; there are numerous large cells at first surrounding the embryo, which farther out form the spiral; between the central larger cells and the large peripheral cells, there are many small ones; they vary in shape from ogival to almost hexagonal and are much wider than high; they attain 170μ in diameter. The vertical section is very thin; it shows one or two of the embryonic cells, a thin equatorial layer of irregular cells connected by single canals. The pillars are small and do not show except in the larger specimens.

This subspecies is so different from *H. spiralis* Tobler that at first it seemed specifically distinct. However, in many collections where both forms are found, it is impossible to divide the specimens into two species as there are so many forms intermediate between the fatter *H. spiralis* Tobler and the new thin subspecies *tenuis*. A very few are almost flat and one or two carry a hump in the center, but these are too scarce to be of interest at present.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality numbers 3306, 3316, 3317.

¹ μ , a micron, is a thousandth of a millimeter.

Subfamily CYCLOCYPEINÆ Brady

Genus DISCOCYCLINA Gumbel

Discocyclina mirandana, n. sp.

Pl. 1, figs. 3, 10, 13.

The microspheric test is small and very thin, attaining 5.5 mm. in diameter; most of the specimens measure 3 mm. or less and are about as thin as possible. The whole surface of the test is ornamented with concentric circles of small, very sharp papillæ. The test gradually thins toward the edges, becoming so translucent that it shows the equatorial cells. The equatorial layer of this microspheric form is composed of distinctly rectangular cells which are small at the center but soon attain dimensions of about 70μ by 50μ . In vertical section the equatorial layer rapidly attains the width which it holds throughout the more adult part of the test; the individual equatorial cells are longer than high; the surface is papillate, but the pillars are indefinite.

The megaspheric form was not found for this species unless it is represented by one specimen of *Discocyclina* which was found in material from Point Bontour, Trinidad. This specimen was about 3.5 mm. in diameter, moderately convex and had an embryo of 2 half embracing cells.

D. mirandana (n. sp.) resembles *Pseudophragmina floridana* (Cushman) H. Douvillé¹ but its equatorial cells are like those of *Discocyclina* and the test attains scarcely half the size of the latter species.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3267, 3295, 3296, 3297, 3308, 3310, 3312, 3313, 3315, 3316, 3317, 3318.

Genus CISSEIS Guppy

Asterodiscus Schaufhäutl, 1863, Süd-Bayerns Lethaea Geognostica, pp. 107-108.

(Not *Asterodiscus* Ehrenberg, 1839, Abh. K. Ak. Wiss. Berlin, p. 130.)

Cisseis Guppy, 1866, Quart. Jour. Geol. Soc. London, vol. 22, p. 584.

¹ H. Douvillé, 1924, Bull. Soc. Géol. France, vol. 23, p. 273, pl. 13, figs. 1-3.

11 Cl., X Bd., 11 Abth., pp. 688-689.

Asterocyclina Gümbel, 1868, Abhandl. der k-bayer. Akad. der Wiss., 11 Cl., X Bd., 11 Abth., p. 689.

Orthophragmina Munier-Chalmas, *partim*, 1891, Etude du Tithonique du Crétacé et du Tertiaire du Vicentin (Thèse de Doctorat), p. 18, *vide* H. Douvillé, Bull. Soc. Géol. France, 1922, p. 56.

As has previously been pointed out,¹ *Asteriatites* (1813), *Asteriacites* (1820) and *Asterodiscus* (1839) as originally used did not apply to Foraminifera. *Aktinocyclina* (1868), *Asterocyclina* (1868) and *Orthophragmina* (1891) are antedated by *Cisseis* (1866), which leaves *Cisseis* the generic name for this group. The genotype is *C. asterisca* Guppy, the only species described at the time. The gender of *asterisca* has been changed as originally it did not agree with the Latin, feminine. proper name, *Cisseis*.

Guppy's original description is as follows:

"Body small, depressed, unattached, divided into rays; oscula few, large, generally disposed along the summits of the rays, and surrounded by more numerous pores, which are developed on both surfaces."

For the present *Cisseis* may as well include all the orbicoids which have rectangular cells and are stellate. Since the rays usually show in the equatorial layer at a very young stage, making the concentric rings of equatorial cells polygonal rather than circular, the group seems sufficiently distinct biologically for generic rank; further, in North America they appear nicely limited to a relatively small stratigraphic unit, the Upper Eocene.²

Although there is quite a variation in the shape of the embryonic cells, it does not seem advisable to propose subgenera until there are more detailed descriptions of many of the species.

The following is a chronological list of some of the species which seem to fall under the genus *Cisseis*, although only

¹ H. K. Hodson, Amer. Jour. Sci., vol. 12, 1926, pp. 353-354.

² T. W. Vaughan, 1924, Bull. Geol. Soc. Amer., vol. 35, p. 791.

fragmentary knowledge is available concerning some of them:

- Cisseis patellaris* (Schlotheim, 1822)
- Cisseis stellata* (d'Archiac, 1846)
- Cisseis radians* (d'Archiac, 1848)
- Cisseis furcata* (Rutimeyer, 1850)
- Cisseis stellaris* (Brunner, 1850)
- Cisseis pentagonalis* (Schafhäütl, 1863)
- Cisseis asterisca* Guppy (1866)
- Orbitoides asterisca* Kaufmann (1867)¹
- Cisseis lucifera* (Kaufmann, 1867)
- Cisseis priabonensis* (Gümbel, 1868)
- Cisseis scarantana* (Gümbel, 1868)
- Cisseis stella* (Gümbel, 1868)
- Cisseis tenuicostata* (Gümbel, 1868)
- Cisseis variecostata* (Gümbel, 1868)
- Cisseis decorata* (Schlumberger, 1904)
- Cisseis gümbeli* (Schlumberger, 1904)
- Cisseis lanceolata* (Schlumberger, 1904)
- Cisseis munieri* (Schlumberger, 1904)
- Cisseis bayani* (Munier-Chalmas, 1904)
- Cisseis taramellii* (Munier-Chalmas, 1904)
- Cisseis rovasendai* (Prever, 1904)
- Cisseis colcanapi* (R. Douvillé, 1906)²
- Cisseis americana* (Cushman, 1917)
- Jisseis georgiana* (Cushman, 1917)
- Cushman mariannensis* (Cushman, 1917)
- Cisseis mariannensis papillata* (Cushman, 1917)
- Cisseis vaughani* (Cushman, 1917)
- Cisseis antillea* (Cushman, 1919)
- Cisseis subtaramellii* (Cushman, 1919)³

¹ *vide* H. Douvillé, 1924, *Mém. Soc. Géol. France*, vol. 1, mem. 2,

² *Annales de Paléontologie*, vol. 1, 1906, p. 66, *vide* W. L. F. Nuttall, 1926, *Records, Geol. Survey India*, vol. 59, pt. 1, p. 151.
p. 19. This will have to be given another name if brought under *Cisseis*.

³ Originally *subtaramellei*, *lapsus calami* for *subtaramellii*.

Cisseis crassicostata (H. Douvillé, 1922)

Cisseis pinguis (H. Douvillé, 1922)

Cisseis præradians (H. Douvillé, 1922)

Cisseis alticostata (Nuttall, 1926)

Cisseis asterisca venezuelana, n. subsp.

Cisseis asterisca zuliana, n. subsp.

Cisseis bontourana, n. sp.

Cisseis pariana, n. sp.

Cisseis harrisi, n. sp.

Cisseis trinidadensis, n. sp.

Cisseis weeksi, n. sp.

Cisseis weeksi maracaibensis, n. subsp.

Cisseis parva, n. sp.

Cisseis sanfernandana, n. sp.

Cisseis aurarensis, n. sp.

***Cisseis asterisca* Guppy**

Pl. 2, figs. 1, 2, 10.

Cisseis asteriscus Guppy, 1866, Quart. Jour. Geol. Soc. London, vol. 22, p. 584, pl. 25, figs. 19 a-b.

Tinoporus asteriscus Guppy, 1892, Quart. Jour. Geol. Soc. London, vol. 48, pp. 534-535.

? *Cisseis asteriscus* Guppy, H. Douvillé, 1924, Mém. Soc. Géol. France, vol. 1, mém. 2, p. 19.

? *Creseis asterodiscus* R. J. L. Guppy, T. W. Vaughan, 1924, Bull. Soc. Geol. Amer., vol. 35, p. 793.

Asteracites asteriscus (Guppy) Harris, 1926, Johns Hopkins University Studies in Geol., no. 7, p. 104, pl. 18, fig. 3.

Guppy's original description:

"Body divided into obtuse, somewhat carinate rays, generally four, but occasionally more; oscula disposed along the summits of the rays, and particularly on the subconical apex; pores numerous.

"The oscula, or larger apertures, are disposed in a group of seven or eight upon the apex, from which a row is continued along the summit of each ray. The general form of the body is that of a small *Palmipes*. Between the rays and towards the margins the pores become smaller and less distinct.

"The nature of this body is so problematical that my object in describing it is rather to make known its existence,

and possibly to obtain some hint as to its true nature, than to draw any inference from its occurrence. It is found in considerable numbers among the *Orbitoides* and *Nummulinæ* at San Fernando, in Trinidad. As it appears by its structure to be more akin to the fossil sponges than to any other organisms, I have described it as such, at the same time giving it a generic name which does not involve any view as to its true affinities. It may possibly be a Foraminifer; but the nature of the pores and the want of division seem to be against that view, and the same characters appear to preclude our placing it with the Echinodermata. In all the specimens I have examined the pores are filled with a mineral infiltration, in a similar manner to those of the *Orbitoides*. The structure is perhaps as near to that of *Sparsispongia* as to that of any other organism."

The megaspheric test is bilaterally symmetrical and averages about 4.2 mm. in diameter. It consists of 4 rays, and is ornamented only slightly by the inconspicuous ends of the pillars. The 4 points or rays of the test are usually somewhat unequal in length. Down the middle of each of these is an irregular row of larger pillars whose ends are just visible at the surface. The test itself is somewhat swollen on each side at the center and ornamented there with the ends of 6-10 larger pillars like those running down the middle of the rays. Each pillar is surrounded at the surface with a single ring of about a dozen very small cells. The horizontal section shows a first round embryonic cell (about 104μ in diameter) half surrounded by another slightly larger one (about 143μ in diameter). The succeeding rows of very small rectangular equatorial chambers are polygonal at first, due to an increase in the number and length of the cells directly under the external rays; then they gradually become star-shaped, assuming the outline of the test. A vertical section through two of the rays usually shows the two embryonic cells, although it sometimes shows only one. In such a section the pillars are strong, especially the larger ones in the middle of the test

and in the middle of the rays; the equatorial layer is very thin near the embryonic cells, but gradually widens out in the rays until at the tips the cells measure 143μ as an average of several sections. The lateral cells are more numerous at the center and thin out toward the periphery, making three scallops on each side of the test; the scallop formed by the center is shorter and higher; there are only about two rows of lateral cells on each side of the equatorial layer at the tips of the rays where the equatorial layer is thickest.

In Venezuela this species does not appear to be so abundant at any locality as it is at Point Bontour, Trinidad.

The microspheric form is unknown.

Since the holotype of *C. asterisca* Guppy seems to be lost, we have chosen topotypes from a bed at Point Bontour which held mostly 4-rayed specimens, and then selected apotypes which most closely corresponded to Guppy's figures and description.

As previously mentioned, the gender of the specific name has been changed to agree with that of the generic.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3268 (variation), 3301 (variation), 3315, 3316; Point Bontour, San Fernando, Trinidad.

***Cisseis asterisca venezuelana*, n. subsp.**

Pl. 2, fig. 6.

This subspecies is very close to *C. asterisca* Guppy in its general shape and ornamentation, but the large size of the test is striking as it attains 5–6 mm. instead of the usual 4 mm. The adjacent edges of the rays are usually thinner and slightly more produced than in the species, making the peripheral outline more rounded and the test flatter.

This subspecies marks the limit in the broadening and flattening of *C. asterisca* Guppy and is usually not so abundant as the intergrading forms.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256 and 3265; Point Bontour, San Fernando, Trinidad.

Cisseis asterisca zuliana, n. subsp.

Pl. 2, fig. 7.

This subspecies is easily distinguished from *C. asterisca* Guppy by its larger size, more elongate rays, and more pronounced keel down the middle of each ray.

Suggestions of this form are found at Point Bontour, Trinidad, but there they seem merely variations and none of them is so distinctly developed or reaches the large size of those from Venezuela.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3316, 3317.

Cisseis bontourana, n. sp.

Pl. 2, figs. 4, 8, 11.

The megaspheric test is small, 4-rayed, rotund and fairly symmetrical. The center forms the larger part of the test and is ornamented with the slightly raised terminals of about a dozen large pillars; the rays are small and carry only a few large pillars. The pillars are each surrounded with about a dozen fair sized lateral cells and separated from each other by about 2 rows of them. The horizontal section shows a small embryonic cell, about 104μ in diameter, half surrounded by a larger one about 119μ in diameter; the equatorial cells are those typical of the genus and show the position of the 4 external rays. The vertical section through 2 of the rays shows the large globular center with many large pillars and the small pointed rays; the equatorial layer is very thin at the center and grows gradually wider toward the ends of the rays.

The microscopic form has not been found.

This species is easily distinguished from similar ones by its rotundity and smaller size. The rays are shorter than in *C. asterisca* Guppy.

Age: Eocene.

Locality: Point Bontour, San Fernando, Trinidad.

Cisseis pariana, n. sp.

Pl. 2, figs. 3, 5, 9.

The megaspheric test is 5 (sometimes 6) rayed, thin, irregular in outline, only slightly raised at the center and down the rays. The pillars are mostly small, but there are larger ones on the rays and especially at the center where there are about two dozen; each is surrounded with a circle of about 10 small cells, and adjacent pillars are usually separated by two complete contiguous circles of these small lateral cells. The rays are unequal and short. The horizontal section shows a first embryonic chamber about 129μ in diameter, half surrounded by one about 161μ in diameter. The cells of the equatorial layer are typical of the genus and are arranged in rays corresponding to the external form. The vertical section is flatly ellipsoid with a very thin equatorial layer whose cells increase in size along the axes of the rays; the pillars are sometimes extremely large at the center or in the middle of the rays but most of them are small.

The microspheric form is unknown.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256 and 3265 (?); Point Bontour, San Fernando, Trinidad.

Cisseis harrisi, n. sp.

Pl. 3, figs. 1, 2, 6.

The megaspheric test is thin, almost flat, rather square, with 4 rays whose points scarcely project beyond the periphery; it is only very slightly swollen, if any, at the center and down the rays. The whole surface is covered with very small, evenly sized papillæ which are only slightly larger at the center and on the rays; each pillar is surrounded by a circle of about 8 cells and usually separated from adjacent ones by 2 contiguous circles of these lateral cells. The horizontal section is almost square in outline, composed of rather large, rectangular median chambers differentiated into 4 rays; the smaller embryonic

chamber measures about 129μ and the larger half embracing one about 150μ in diameter. The vertical section through the center is thin and of a uniform thickness until almost at the periphery where it narrows abruptly; the equatorial layer increases in width toward the periphery in the rays; the pillars are slender and fairly numerous.

The microspheric test is unknown.

Named in honor of Prof. G. D. Harris, who collected the material.

Age: Eocene.

Locality: Point Bontour, San Fernando, Trinidad.

Cisseis trinidadensis, n. sp.

Pl. 3, figs. 4, 7, 10.

The megaspheric test is 5-rayed, rather plump and ornamented with 15–20 larger pillars at the raised center and with a few more down the rays. The rays are slender, prominent and unequal; one of them is especially long. The pillars are separated usually by 2 contiguous circles of small cells. The horizontal section shows the outline of the test with the typical equatorial cells differentiated into 5 rays; the embryonic cells were recrystallized, but the larger one measures about 150μ in diameter. The vertical section through a ray is slightly scalloped in outline; in vertical section the equatorial cells are unusually large through the center of a ray, increasing in width toward the periphery; the numerous wide pillars are interspersed among the lateral chambers.

The microspheric form has not been found.

This species seems to resemble *C. tarqmellii* (Munier-Chalmas) (*partim*),¹ but the equatorial layer increases in width in the rays as it approaches the periphery instead of remaining uniform as in the latter.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality numbers 3268, 3316; Point Bontour, San Fernando,

¹ Ch. Schlumberger, 1904, Bull. Soc. Géol. France, vol. 4, p. 131, pl. 6, figs. 41, 42.

Trinidad.

Cisseis weeksi, n. sp.

Pl. 3, figs. 3, 5, 8.

This peculiar form is probably almost square, but it is so thin and fragile that all the specimens were somewhat broken. The surface is somewhat papillate, especially at the slightly raised center and down the 4 diagonal, raised rays; on the edges of the test between the rays, the rectangular equatorial cells are visible by transmitted light. The rays are not enlarged in the middle but are of rather even size from the center to the periphery. The pillars are small. The equatorial layer is very difficult to section as it is irregular and not all in one plane. The equatorial cells are small and typical in shape surrounding the half embracing embryonic cells which measure 134μ and 102μ , respectively.

The microspheric form is unknown.

Named in honor of Mr. L. G. Weeks who made most of the Venezuelan collections used in this article.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality number 3256.

Cisseis weeksi maracaibensis, n. subsp.

Pl. 3, fig. 9.

This subspecies has much the same general square form and thinness as the species, but the center and rays are raised higher. The center, especially, is more papillate, carrying about a dozen prominences. Like the species, this form is so thin that it is easily broken and no perfect specimens were found. The equatorial layer is warped; the rectangular cells are of a fair size and specialized to form the 4 rays; the larger embracing embryonic cell measures about 150μ , the smaller one about 108μ .

C. weeksi maracaibensis (n. subsp.) resembles the figures of *C. georgiana* (Cushman)¹ but is only about half

¹ J. A. Cushman, 1920, U. S. Geol. Survey Prof. Paper 125-D, p. 45, pl. 10, fig. 1.

the size of the latter.

The microspheric form is unknown.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality number 3256.

Cisseis parva, n. sp.

Pl. 4, figs. 2, 4.

The megaspheric test is small, convex at the center, thin at the edges. It carries 4 rays, one of which is longer and more prominent than the rest. At the center there are about 6 large papillæ which are more prominent than the rest on the test. The rays are not raised much in height from the general plane of the test, but are ornamented by occasional large papillæ and project irregularly beyond the periphery. The lateral cells are large, rather irregular, and easily visible on the plump part of the disk; at the thin edges the rectangular medial cells sometimes show through. The cells of the horizontal layer are rather irregular in size and specialized into 4 narrow rays. The larger embryonic cell measures about 150μ , the smaller one 108μ .

The microspheric form is unknown.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality number 3256.

Cisseis sanfernandana, n. sp.

Pl. 4, fig. 3.

The test is 5-rayed, large, measuring about 6.5 mm. and webbed between the rays. On one side the rays and center are sharply elevated above the rest of the test and the pillars are so large that their surface extremities are transversely elongated across the rays; this makes the rays resemble chickens' legs with overlapping scales. On the same side, the area between the rays shows a small fold well out toward the periphery; this prominence is ornamented with terminals of pillars slightly larger than those on the flat portion of the test. On the opposite side, the rays are less prominent and the area between them is flat

and bears only small terminals of pillars. The ends of the pillars are only slightly raised above the surface and there is no network.

This species is so rare at Point Bontour that not enough specimens were available for sectioning.

Age: Eocene.

Locality: Point Bontour, San Fernando, Trinidad.

***Cisseis aurarensis*, n. sp.**

Pl. 4, figs. 1, 6, 7, 8.

The test is of medium size, convex at the center, covered with an irregular mesh which is coarse at the center. The rays are produced beyond the main part of the test in narrow straight projections resembling the rays on *Lepidocyclina martini* Schlumberger,¹ and different from those on most of the other species of *Cisseis*. These are very easily broken off and seldom preserved fast to the test. The equatorial layer has an embryo of two half embracing cells, which together measure about 160 μ . The large rectangular equatorial cells are arranged to form 5–8 rays. In vertical section the equatorial layer increases in width in the rays toward the periphery; the pillars are very strong at the center.

This species is easily distinguished from the others as it looks more like a stellate *Lepidocyclina* than like a *Cisseis*.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality numbers 3283 (or variety), 3315, 3316, 3318, 3344 (or variety).

Genus LEPIDOCYCLINA Gumbel

Subgenus LEPIDOCYCLINA (s. s.)

***Lepidocyclina* (*Lepidocyclina*) *trinitatis* H. Douvillé** Pl. 4, fig. 10.

Isolepidina pustulosa A. H. Douvillé, 1917, Comptes Rendus Acad. Sci., vol. 164, p. 844, fig. 3, non fig. 4.

Isolepidina Trinitatis H. Douvillé, 1924, Bull. Soc. Géol. France, vol. 1, mém. no. 2, pp. 34–35, figs. 7–12, pl. 1, fig. 1.

Lepidocyclina (*Lepidocyclina*) *trinitatis* H. Douvillé, T. W. Vaughan, 1924, Bull. Geol. Soc. Amer., vol. 35, p. 797.

¹ C. Schlumberger, 1900, Samm. Geol. Reichs. Leiden, Ser. 1, Band 6, Heft 3, p. 131, pl. 6, figs. 5–8.

Isolepidina trinitatis H. Douvillé, G. D. Harris, 1926, Johns Hopkins University Studies in Geol., no. 7, pp. 104, 107.

L. trinitatis H. Douvillé in its megaspheric and microspheric forms is abundant at Point Bontour, Trinidad, and many localities in Venezuela. It usually occurs with many variations; two of the more common are described subsequently as subspecies.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3303 (?), 3305, 3312; Point Bontour, San Fernando, Trinidad.

***Lepidocyclina trinitatis caribbeanensis*, n. subsp.** Pl. 4, fig. 5.

This subspecies includes the forms of *L. trinitatis* H. Douvillé which have the keel greatly extended. There are all variations between the species (*s. s.*) and the two new subspecies *caribbeanensis* and *venezuelana*. The cells are a little more irregular in arrangement than in the species (*s. s.*) and the embryo attains almost 600 μ .

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3308 (?); Point Bontour, San Fernando, Trinidad.

***Lepidocyclina trinitatis venezuelana*, n. subsp.** Pl. 4, fig. 9.

This form differs from *L. trinitatis* H. Douvillé (*s. s.*) by being flatter on one side. The test is like that of the species (*s. s.*) on one side but the other side is only slightly convex instead of being so very high. There are all gradations between this subspecies, the species (*s. s.*) and the other new subspecies *caribbeanensis*. The vertical and horizontal sections show that the equatorial layer is not in one plane but is raised at the center toward the more convex side; this makes it equidistant between the two discoid surfaces. A similar raising of the center of the equatorial layer is usually found in forms which are not bilaterally symmetrical. The embryo attains 600 μ in diameter.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3301; Point Bontour, San Fernando, Trinidad.

Lepidocyclina (**Lepidocyclina**) **bontourana**, n. sp. Pl. 5, figs. 2, 4, 5.

This species resembles very closely *L. trinitatis* H. Douvillé which is so abundant at Point Bontour. Although *L. bontourana* (n. sp.) measures only about 2.4 mm. in diameter, the megaspheric tests of the two species are almost identical externally,—very rotund, almost globular, and with a narrow border at the edge. Internally, the embryo of 2 cells is very large, measuring from about 770 to 860 μ in diameter contrasting with the much smaller one in *L. trinitatis* H. Douvillé. In horizontal section the embryo of this species is surrounded with a layer, usually single, of very narrow equatorial cells that sometimes extend almost a quarter of the way around it. Outside of these, the cells gradually assume an ogival shape and measure about 75 μ in diameter. In vertical section the pillars are irregular in size and arrangement; the equatorial layer on each side of the large embryo is short and composed of large cells.

Only the megaspheric form has been recognized. The microspheric forms of *Lepidocyclina* are usually not given a specific determination in this article because in most localities there are many species which are so much alike that it is impossible to tell which microspheric forms correspond to the various megaspheric forms.

Age: Eocene.

Locality: Point Bontour, San Fernando, Trinidad.

Lepidocyclina (**Lepidocyclina**) **hubbardi**, n. sp.

Pl. 5, figs. 1, 3, 7, 11.

The megaspheric test is very thin and attains 5.5 mm. in diameter. The center is somewhat swollen, ornamented in the adult with a mesh carrying about a dozen small papillæ which mark the ends of the pillars. This is bor-

dered by a wide, thin margin which shows the cells of the equatorial layer. It is abundant at some localities and varies somewhat in shape. Some of the specimens have the center higher on one side than on the other; in some, the central swelling spreads out farther, narrowing the thin border, in others it is more centralized and the border is wider. The horizontal section shows an embryo of 2 subequal cells measuring as an average 470μ , but attaining 560μ , as in *L. trinitatis* H. Douvillé. The equatorial cells are ogival and arranged in intersecting curves; the first ones are larger, measuring around 170μ ; the peripheral ones, smaller, measuring about 64μ . The vertical section of an adult shows an equatorial layer markedly increasing in width toward the periphery where it forms the major part of the test; the pillars are strong at the center especially in the fatter forms, irregular in arrangement and end in papillæ.

This species usually occurs together with its two new subspecies *bolivarensis* and *aurarensis*. At Point Bontour, Trinidad, it is more rare than in Venezuela and shows some variation, having usually a smaller embryo and cells; however, the specimens from the two localities are specifically identical. Only the megaspheric form has been recognized.

Named in honor of Dr. B. Hubbard.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulía, Venezuela, locality numbers 3256, 3262 A, 3265, 3267, 3301, 3303 (and variation), 3308 (and variation), 3314, 3315, 3318; Point Bontour, San Fernando, Trinidad.

Lepidocyclina hubbardi bolivarensis, n. subsp.

Pl. 5, fig. 10; Pl. 6, fig. 1.

This subspecies comprises the variations of *L. hubbardi* (n. sp.) which are fatter and have an evenly convex surface instead of a hump at the center with a thin border at the edge, as is characteristic of the species (s. s.). *L. hubbardi bolivarensis* (n. subsp.) is thicker than the

other new subspecies *aurarensis*. The equatorial layer is like that of the species (*s. s.*).

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3267, 3301, 3314, 3316; Point Bontour, San Fernando, Trinidad.

***Lepidocyclina hubbardi aurarensis*, n. subsp.** Pl. 5, figs. 6, 8, 9.

This subspecies marks the limit of variation in *L. hubbardi* (*n. sp.*) toward a very thin form lacking the central hump.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3316, 3318; Point Bontour, San Fernando, Trinidad.

***Lepidocyclina (Lepidocyclina) weeksi*, n. sp.** Pl. 6, figs. 6-8.

The test is small, moderately convex, and without any encircling collar or thin margin. The surface is covered with an irregular mesh. The equatorial layer has a bicellular embryo measuring about 450-700 μ in diameter; the ogival equatorial cells are larger at first and later become more regular, arranged in intersecting curves, and measure about 60-80 μ . The vertical section shows a good sized embryo, irregularly arranged pillars and large lateral cells; the equatorial band scarcely increases in width laterally.

It is closest to *L. trinitatis* H. Douvillé, but is thinner, lacks the encircling collar and has a little larger embryo.

Only the megaspheric form is known, but with this species occurs a microspheric form which may be specifically identical. Due to the similarity in the arrangement of pillars and in the size and shape of the equatorial cells in *L. (Polylepidina) mirandana* (*n. sp.*) and *L. (Lepidocyclina) weeksi* (*n. sp.*), both of which are found in the same collection, one cannot tell of which species this is the microspheric form. The cells of this unidentified microspheric form are more elongate and closer together and the

walls thinner than in the microspheric form of *L. trinitatis* H. Douvillé; most of the specimens are usually a little smaller.

Named in honor of Mr. L. G. Weeks, who collected most of the Venezuelan material used in this article.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3262 A, 3265, 3267, 3268, 3301, 3304, 3305, 3312, 3317; Point Bontour, San Fernando, Trinidad.

Lepidocyclina (*Lepidocyclina*) *maracaibensis*, n. sp. Pl. 6, figs. 2-4.

The test is small, attaining 1.6 mm. in diameter. It is very fat, peaked at the center, and slopes rapidly down to the rather thin encircling collar. The surface is covered with a coarse irregular mesh without much evidence of pillars. The equatorial layer shows an embryo of two subequal cells surrounded by a common wall; they measure about 268μ in diameter; the equatorial cells are a little larger at first, about 75μ , later decreasing to about 53μ in diameter where they are arranged in intersecting curves. The vertical section shows an equatorial layer increasing in diameter toward the periphery. There are a few rather large irregularly spaced pillars which are especially apparent in the larger forms.

Only the megaspheric form has been found and this is rare.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality number 3268.

Subgenus NEPHROLEPIDINA H. Douvillé

Lepidocyclina (*Nephrolepidina*) *kochi*, n. sp. Pl. 6, figs. 5, 9, 10.

The test is moderately convex with practically no encircling collar; it attains a little over 3 mm. in diameter. The surface of well preserved specimens is covered with an irregular mesh which is coarsest at the center where there

are medium sized papillæ. The equatorial layer shows the striking feature of this species,—an embryonic apparatus intermediate between *Lepidocyclina* (s. s.) and *Nephrolepidina*; a very small percentage of the specimens are typical of the genus (s. s.), about one-fourth have a *Nephrolepidina* embryo and the rest are intermediate between the two. The embryo measures from 400 to 700 μ , but most are about 500 μ in diameter. The equatorial layer is composed of ogival cells arranged in intersecting curves; these are larger and more irregular at the center, but at the periphery they measure from 60 to 75 μ in diameter. The vertical section shows that the equatorial layer increases in width laterally, and that the irregularly arranged pillars are stronger at the center.

Only the megaspheric form is known.

Named in honor of Dr. Rich. Koch.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulia, Venezuela, locality numbers 3256, 3265, 3267, 3301, 3303, 3305, 3312, 3314, 3317; Point Bontour, San Fernando, Trinidad.

Subgenus POLYLEPIDINA Vaughan

Lepidocyclina (*Polylepidina*) *zuliana*, n. sp. Pl. 7, figs. 1-3.

The test is less than 3 mm. in diameter and about 0.5 mm. in height; flatly elliptical in outline, thinning gradually toward the periphery. The surface is ornamented with several fairly large papillæ; in the young specimens the cells of the equatorial layer are easily distinguishable on the margin, but in older ones the surface is covered with merely a coarse loose mesh. The equatorial layer shows a peculiar embryo about 480 μ in diameter, of which usually 3 cells can be distinguished in a given section. The first equatorial cells are wider than high, ogival, large and irregularly arranged (about 100 μ in diameter). Then they usually become smaller (about 50 μ in diameter) and more regularly arranged in intersecting curves. The vertical

section shows elliptical lateral cells and very indistinct pillars; the embryo is irregular and flanked by an equatorial layer of first irregular, and later ogival, almost square, cells which increase only slightly in size toward the periphery.

Only the megaspheric form is known.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality number 3268.

Lepidocyclina (Polylepidina) mirandana, n. sp. Pl. 7, figs. 4-6.

The test is small, about 2.5 mm. in diameter, of moderate thickness, frequently higher on one side than the other, and frequently surrounded with a small projecting collar. The surface is usually weathered on the specimens available and shows only a rather coarse network. The equatorial layer is remarkably irregular in shape; the embryo usually shows 3 good sized cells and measures around 1.075 mm. in diameter; the ogival equatorial cells are a little larger at the center but soon measure about 75μ , some larger or smaller, and are arranged in intersecting curves. The vertical section shows a very long narrow embryo with irregular equatorial and lateral cells; the pillars are fairly numerous and vary in width and arrangement in the same specimen.

Only the megaspheric form was recognized although there is a microspheric form associated with it which may be of the same species. Due to the similarity of the arrangement of pillars and in the size and shape of the equatorial cells between *L. (Polylepidina) mirandana* (n. sp.) and *L. (Lepidocyclina) weeksi* (n. sp.), both of which are found in the same collection, one cannot tell to which of these the microspheric form belongs.

This species is easily distinguished from *L. (Polylepidina) zuliana* (n. sp.) by its larger pillars and more convex shape.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela,

locality number 3312.

Lepidocyclina (Polylepidina ?) churugaritana, n. sp. Pl. 7, figs. 7, 8.

This species is small, measuring not over 2.5 mm., doubly sellate, covered with a network which is coarser at the center. The form is rare but sometimes occurs with striking variations: it may be only slightly doubly sellate, typical, or so very doubly sellate that two ends or two adjacent edges or both may grow together making one side flat like the top of an ordinary *Lepidocyclina* while the other side may look like a wedge or spine. It was impossible to tell to what subgenus this species belongs as the embryo was not distinct enough in either vertical or horizontal sections to warrant a decision; it seemed to consist of 1, 2, or 3 cells which measured about 107μ each and seemed arranged in a row. What few equatorial cells were seen at the center were ogival. The vertical section shows a few poorly defined pillars.

Age: Eocene.

Locality: Districts of Miranda and Bolívar, State of Zulía, Venezuela, locality numbers 3265, 3268, 3317.

Subgenus PLIOLEPIDINA H. Douvillé

Lepidocyclina (Pliolepidina) sp.

In the collections from Point Bontour, Trinidad, there is one specimen of what seems to be *L. (Pliolepidina) tobleri* H. Douvillé.¹ From one locality in Venezuela there was one specimen which had a practically identical equatorial layer, but whose other characteristics make it seem specifically distinct from *L. tobleri*. It seems to belong to the same subgenus, which had not as yet been recorded from Venezuela in the literature. From the same locality among the *Polylepidina* and *Pliolepidina*, are individuals with very strange embryos consisting of many cells of which one or two are tremendous in size and irregular in shape. They seem to be teratologic and are not found elsewhere. One embryo measured 2.9 mm. in greatest diam-

¹ H. Douvillé, 1924, Mém. Soc. Géol. France, vol. 1, mém. 2, pp. 43-44, figs. 34-35.

eter.

Age: Eocene.

Locality: District of Miranda, State of Zulia, Venezuela, locality number 3312.

Genus MIOGYPSINA Sacco

Miogypsina hawkinsi, n. sp.

Pl. 7, fig. 9; Pl. 8, figs. 1, 2.

The test does not exceed 2 mm. in diameter, is more convex on one side than the other, and covered with large papillæ. It is quite thick and the greatest thickness is reached just a little off center near the embryo; around the edge is a thin encircling collar which is usually broken. The equatorial layer shows the embryo near the periphery, consisting of one spherical cell measuring about 160μ and another larger one almost hemispherical, measuring about 215μ , placed above it a little diagonally to the long axis of the test. This second one is followed by the spiral of 5-7 cells, usually 6. The first of these is largest, measuring about the same as the first spherical cell of the embryo in its greatest dimension but it is more irregular in shape. The next cells are successively smaller until there is a very small one (usually the fifth) which is followed by the remaining larger ones. The equatorial cells are arranged in intersecting curves and are only slightly longer than wide, measuring usually $107 \times 140\mu$; occasionally one attains 160μ in greatest diameter. A vertical section through the center shows prominently the first spherical cell of the embryo with a large cell above and two below it; the wide equatorial cells are almost square and thick walled; the lateral cells irregular; the pillars more prominent at the center.

This species is easily distinguished from *M. venezuelana* (n. sp.) by its very small size, by the position of the second embryonic cell which is obliquely above the first one instead of along side of it, and by the smaller size of the embryo. From *M. staufferi* Koch¹ it differs in being

¹ Rich. Koch, 1926, *Eclogæ geol. Helvetiæ*, vol. 19, no. 3, pp. 751-753, pl. 28, figs. 1-3.

smaller, in carrying its embryo nearer the periphery, and in the size of the second embryonic cell which is relatively larger than the first one. From *M. cushmani* Vaughan¹ which it resembles more closely, it differs in the smaller size of the first embryonic cell, and the much smaller size of the equatorial cells ($140-160\mu$ instead of $200-249\mu$); this great difference in embryonic apparatus with no forms intergrading between the two would make the Venezuelan form of specific rather than subspecific rank.

One dwarfed specimen was found whose first embryonic cells measured 107μ instead of 160μ , and all of the other cells were correspondingly small; the arrangement of the cells was typical of the species.

Named in honor of Mr. G. D. Hawkins, who helped collect the material.

Age: Oligocene-Miocene.

Locality: District of Buchivacoa, State of Falcón, Venezuela, locality number 3514.

***Miogypsina venezuelana*, n. sp.**

Pl. 8, figs. 3-6.

The test of this species is very large and thin and easily broken; consequently, only fragments have been found, but some of these pieces measure 7 mm. in diameter so that whole specimens must attain 10 mm. The outside is evenly covered with small, equal papillæ; one side is more convex than the other, but as yet the shape of the whole test has not been seen. The horizontal sections show the embryo situated near the periphery; it consists of 2 large distinct cells, one spherical and measuring about 215μ , the other at its side and more hemispherical, measuring about $270-300\mu$ in its greatest dimension. The spiral which begins at the second cell of the embryo consists of 7-8 cells; the first 3 or 4 are successively smaller, the first and largest of which measures about 160μ and is usually irregular in

¹ T. W. Vaughan, 1924, Bull. Geol. Soc. Amer., vol. 35, pp. 802, 803, 813, pl. 36, figs. 4-6.

shape. These are usually followed by 1-3 very small irregular poorly defined cells, and then by 2 or 3 larger cells. One specimen was found in which the first cell of the spiral was almost as large as the first cell of the embryo but the section was slightly oblique and the individual probably a little abnormal. The equatorial cells are smaller near the embryo where they are rather square in shape and as small as 110μ ; they increase in size toward the periphery and become increasingly diamond-shaped until at the side opposite the embryo they attain $320 \times 215\mu$. The vertical sections are unsatisfactory as yet, for since most of the specimens are fragmentary it is hard to orient them right to produce a vertical section through the embryo; however, it can be seen that the lateral cells are small and numerous; the pillars are quite regular in size and distribution, ending in small papillæ on both surfaces of the test.

The species is strikingly different from all other discovered in the new world,—it is so large. The location of the second cell of the embryo is at one side instead of above the first cell of the embryo as in *M. staufferi* Koch, and the spiral cells are conspicuously smaller than the embryonic ones.

Age: Oligocene-Miocene.

Locality: District of Buchivacoa, State of Falcón, Venezuela, locality numbers 17, 2187, 3514.

PLATES

Printed plates furnished by Mr. and Mrs. Hodson

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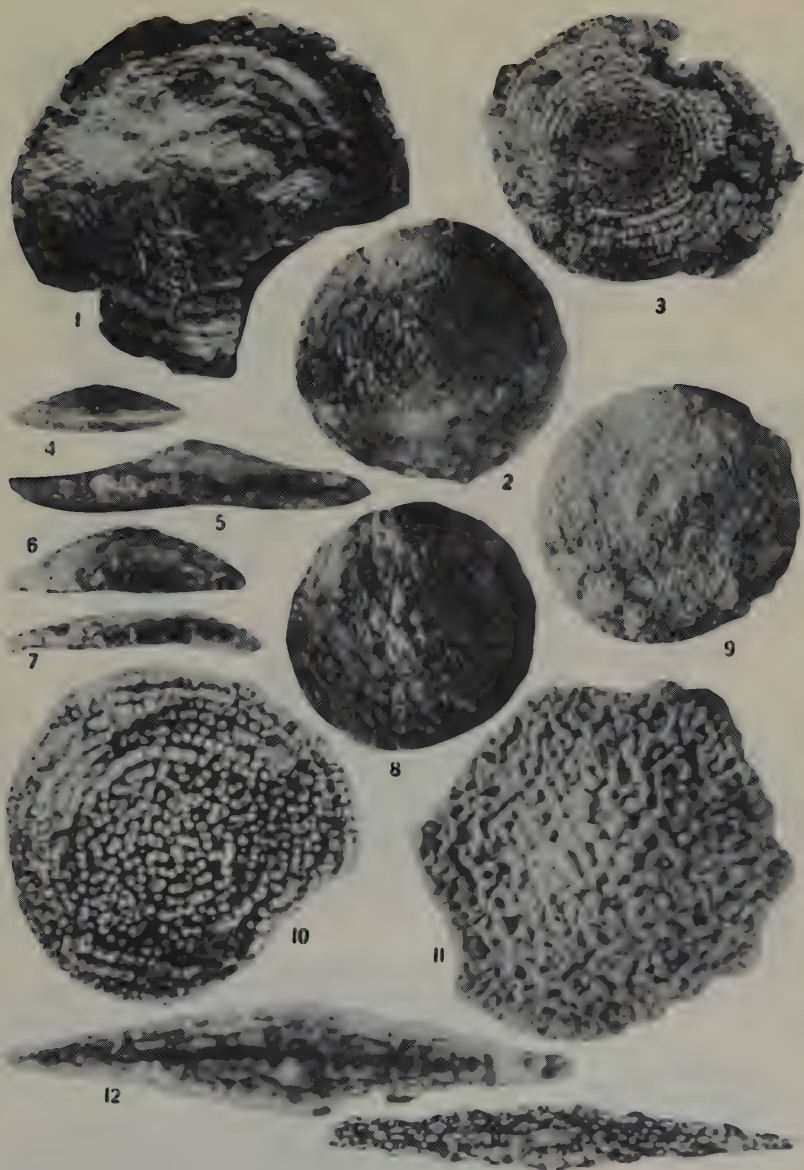


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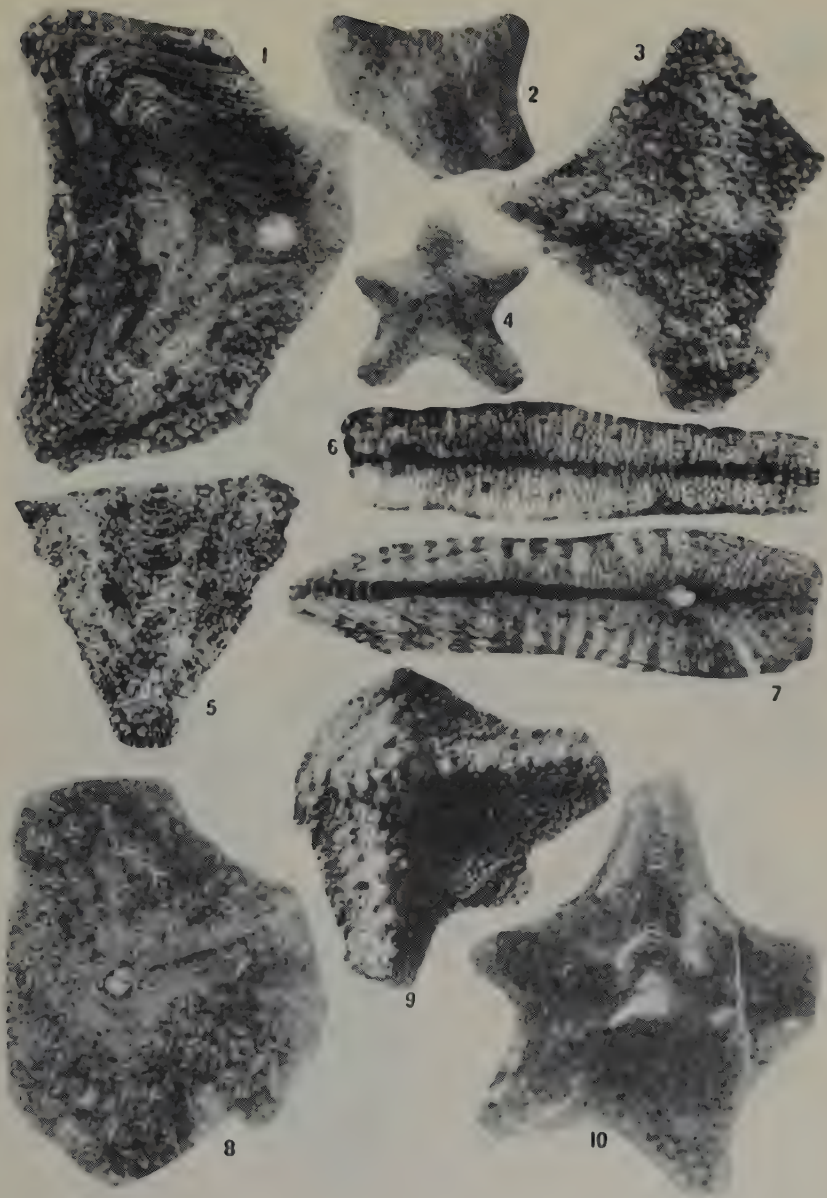


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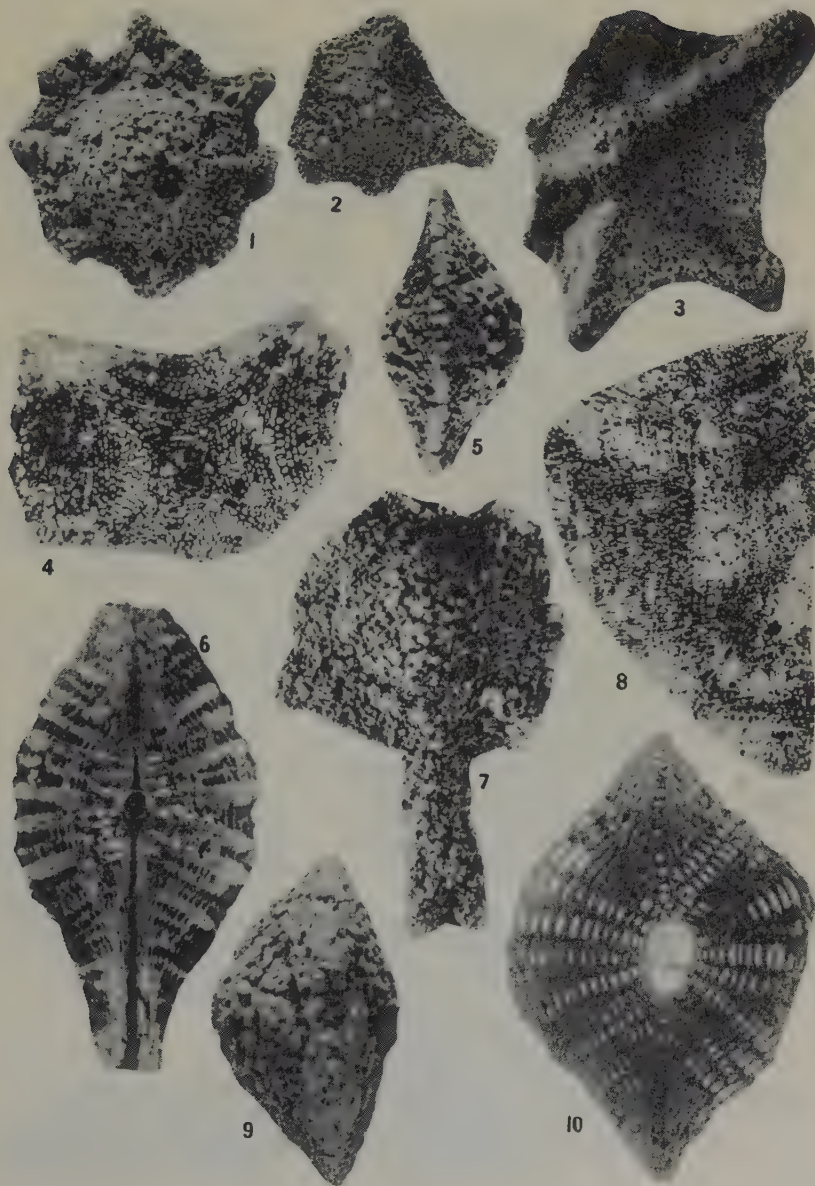


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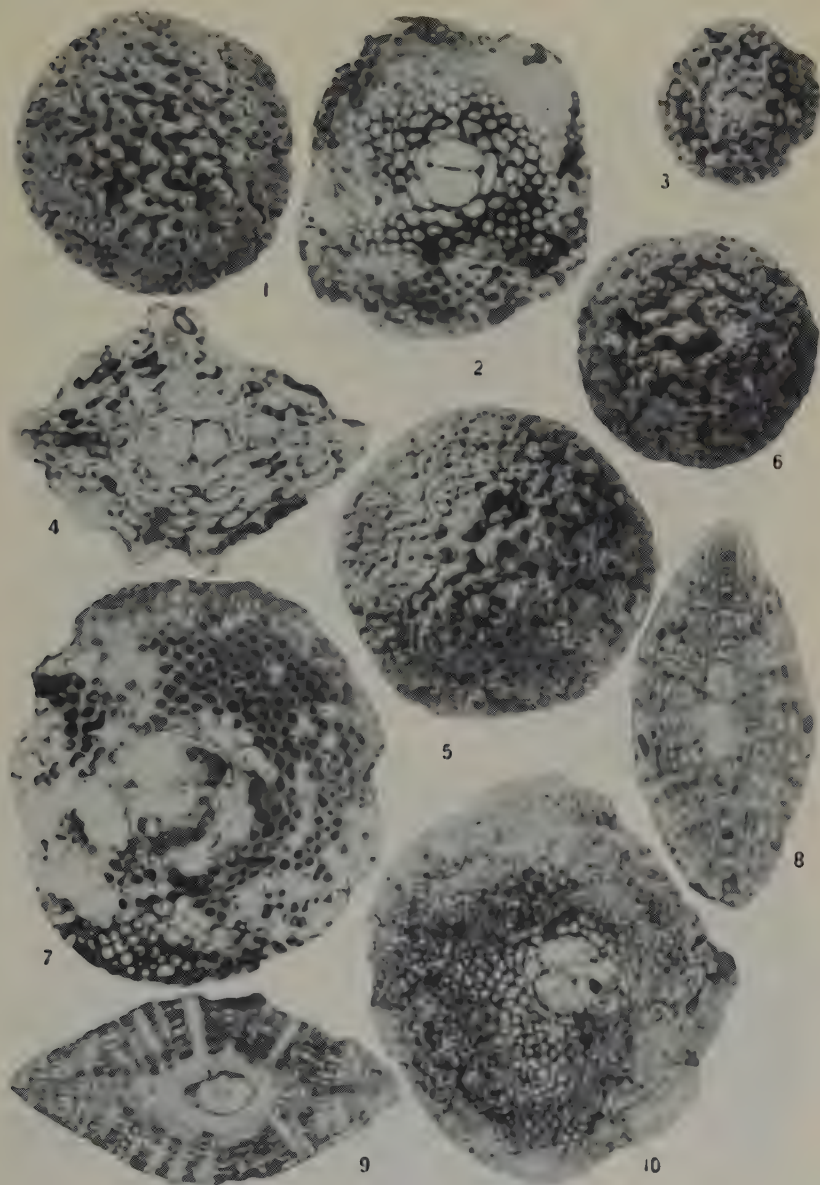


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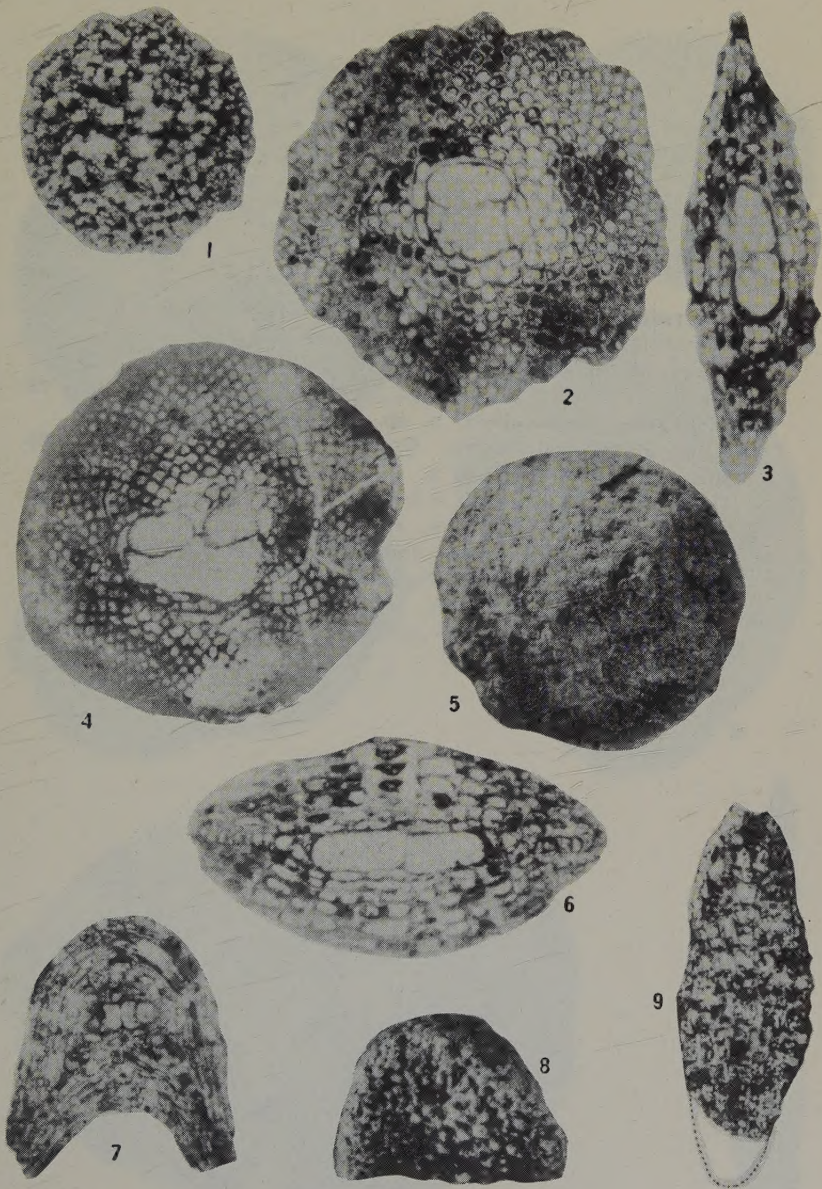


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